STUDENT STUDY PROJECT

TITLE: THE APPLICATIONS OF SYSTEM OF LINEAR EQUATIONS IN NETWORK FLOW

Submitted to

THE DEPARTMENT OF MATHEMATICS

KNM GOVERNMENT DEGREE COLLEGE-MIRYALGUDA

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CONTENT:

1.Abstract:

We find one application on "The system of linear equations" which is useful in real world.

2. Keywords:

Network, Junction (or) Node and Branches , Linear equations and Matrix

3. Introduction[Literary review] :

Linear Equations were invented by the famous Irish mathematician, Sir William Rowan Hamilton in the year 1843. "The system of linear equations" is an important concept in Mathematics because many real world problems can be solved by using this concept. The system of linear equations have so many applications in real life. Linear algebra enjoys a close relationship with linear equations. Linear algebra highlights linear equations and the relationship between variables.

Some applications of Linear Equations:

There are various real-life examples of linear equations. These real-life problems are converted into mathematical forms to form linear equations which are then solved using various methods. It should clearly explain the relationship between the data and the unknowns (variables) in the situation. Below mentioned are the steps to be taken while converting a real-life problem into a linear equation:

- Writing the word problem as a mathematical statement in the form of an algebraic expression.
- The quantities whose value can keep changing with time and different inputs are said to be variable quantities. These should be identified and assigned as variables.

- The information given in the problem should be translated and written in a sequential manner.
- After that, equations need to be framed with algebraic expressions and data cited in the word problems.
- These linear equations can then be solved to find out the value of the unknown variables using various methods of equation solving.
- The solutions should be retraced and verified for their correctness and to ensure that they meet all the criteria mentioned in the problem.

Some Common Applications of Linear Equations in Real Life Involve Calculations of:

- Age problems
- Speed, time and distance problems
- Geometry problems
- Money and percentage of problems
- Wages and hourly rate problems
- Force and pressure problems

Linear equation:

A linear equation in the variables $x_1, x_2, x_3, , \ldots\ldots, x_n$ is an equation that can be written in the form $a_1x_1 + a_2x_2 + \ldots\ldots + a_nx_n = b$ where b and $a_1 , a_2, \ldots\ldots, a_n$ are real or complex numbers.

System of linear equations:

A system of linear equations is a collection of one or more linear equations involving the same variables say $x_1, x_2, x_3, , \ldots\ldots, x_n$.

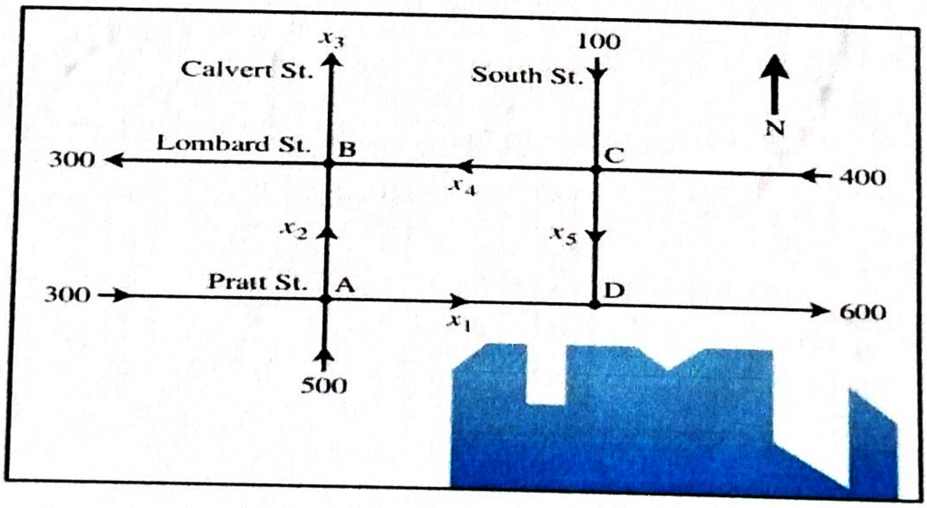
NETWORK FLOW:

System of linear equations arise naturally when scientists, engineers or economists study the flow of some quantity through a network. For instance, urban planners and traffic engineers monitor the pattern of traffic flow in a grid of city streets. Electrical engineers calculate current flow through electrical circuits and economists analyse the distribution of products from manufactures to consumers through a network of wholesalers and retailers. For many networks, the systems of equations involve hundreds or even thousands of variables and equations.

A network consists of a set of points called junctions or nodes, with lines or arcs called branches connecting some or all the junctions. The direction of flow in each branch is indicated, and the flow amount (or rate) is either shown or is denoted by a variable.

The basic assumption of network flow is that the total flow into the network equals the total flow out of the network and that the total flow into a junction equals the total flow out of the junction.

The network in the following figure shows the traffic flow (in vehicles per hour) over several one –way streets in Miryalaguda .



From the above figure the street intersections (junctions) and the unknown flows in the branches at each intersection, the flow in equal to the flow out.

Intersection	Flow in = Flow out
A	$300+500 = x_1 + x_2$
B	$x_2 + x_4 = 300 + x_3$
C	$100+400 = x_4 + x_5$
D	$x_1 + x_5 = 600$

Also the total flow into the network = the total flow out of the network

$$500+300+100+400 = 300 + x_3 + 600$$

$$x_3 = 400$$

From the table we have $x_1 + x_2 = 800$

$$x_2 - x_3 + x_4 = 300$$

$$x_4 + x_5 = 500$$

$$x_1 + x_5 = 600$$

$$x_3 = 400$$

The matrix form of the above system of equations is AX = B

$$\text{Where } A = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & -1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 \end{bmatrix}, X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix} \text{ and } B = \begin{bmatrix} 800 \\ 300 \\ 500 \\ 600 \\ 400 \end{bmatrix}$$

Now The augmented matrix $[A \quad B] = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & -1 & 1 & 0 & 300 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 1 & 0 & 0 & 0 & 1 & 600 \\ 0 & 0 & 1 & 0 & 0 & 400 \end{bmatrix}$

$R_4 \to R_4 - R_1$

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & -1 & 1 & 0 & 300 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & -1 & 0 & 0 & 1 & -200 \\ 0 & 0 & 1 & 0 & 0 & 400 \end{bmatrix}$$

$R_4 \to R_4 + R_2$

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & -1 & 1 & 0 & 300 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & -1 & 1 & 1 & 100 \\ 0 & 0 & 1 & 0 & 0 & 400 \end{bmatrix}$$

$R_4 \to R_4 - R_3$

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & -1 & 1 & 0 & 300 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & -1 & 0 & 0 & -400 \\ 0 & 0 & 1 & 0 & 0 & 400 \end{bmatrix}$$

$R_5 \to R_5 + R_4$

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & -1 & 1 & 0 & 300 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & -1 & 0 & 0 & -400 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$R_4 \to (-1)R_4$

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & -1 & 1 & 0 & 300 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & 1 & 0 & 0 & 400 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$R_2 \to R_2 + R_4$

$$\begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 800 \\ 0 & 1 & 0 & 1 & 0 & 700 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & 1 & 0 & 0 & 400 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$R_1 \to R_1 - R_2$

$$\begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 100 \\ 0 & 1 & 0 & 1 & 0 & 700 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & 1 & 0 & 0 & 400 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$R_1 \to R_1 + R_3$, $R_2 \to R_2 - R_3$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 600 \\ 0 & 1 & 0 & 0 & -1 & 200 \\ 0 & 0 & 0 & 1 & 1 & 500 \\ 0 & 0 & 1 & 0 & 0 & 400 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

This is in Row reduced echelon form

The linear equations of above matrix are $x_1 + x_5 = 600 \Rightarrow x_1 = 600 - x_5$

$x_2 - x_5 = 200 \Rightarrow x_2 = 200 + x_5$

$x_4 + x_5 = 500 \Rightarrow x_4 = 500 - x_5$

$x_3 = 400$

Here x_5 is free variable

Since the street in this problem are one-way , none of the variables here can be negative. So that $x_5 \leq 500$ because x_4 cannot be negative.

4. Methodology : Problem solving method

5. References : (i) Google Searching.

(ii) David C Lay Linear Algebra and its applications 4e

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